Government of the United States the expression of the thanks of the Royal Society for the steps taken to ascertain the fate of the expedition under Sir John Franklin, F.R.S., and to afford relief if it shall be necessary."

June 14, 1849.

The EARL OF ROSSE, President, in the Chair.

His Lordship announced, that in accordance with the resolution of the Society, requesting him to communicate the thanks of the Society to the Government of the United States for the steps taken by them to ascertain the fate of the Expedition under Sir John Franklin, he had addressed the following letter to His Excellency the American minister:—

My dear Sir, 3 Connaught Place, June 8, 1849.

I have the honour to inform you, that at the annual meeting of the Royal Society, held the 7th inst., a communication was read from Admiral Sir Francis Beaufort, in which he apprised the Society that the American Government had nobly undertaken to send an expedition in search of Sir John Franklin. Upon which a vote of thanks was moved by Sir Charles Lemon, seconded by Lord Northampton, and carried with the utmost enthusiasm, expressive of the gratitude of the Royal Society to the American Government, and of their deep sense of the kind and brotherly feeling which had prompted so liberal an act of humanity. Allow me to assure you, that it is peculiarly gratifying to me to have the honour of being the humble instrument in conveying to you the thanks of the Royal Society on this occasion, and permit me to express a hope that this most generous act of the United States may, if possible, draw closer the bonds of friendship between the two kindred nations.

That the United States may continue to progress with the same extraordinary rapidity in the arts of peace and civilization, and to hold the same high place in the science and literature of the world, is I am sure the anxious desire of the Royal Society.

I have the honour to be,
My dear Sir,
Your most obedient humble Servant,
Rosse, P.R.S.

The following papers were read:—

1. "On Carbonate of Lime as an ingredient of Sea-water." By John Davy, M.D., F.R.S. Lond. & Ed., Inspector-General of Army Hospitals, &c.

The manner in which limestone cliffs rising above deep water are worn by the action of the sea, as it were by a weak acid, such as we know it contains, viz. the carbonic—the manner, further, in which the sand on low shores where the waves break, becomes consolidated, converted into sandstone, by the deposition of carbonate of lime

from sea-water owing to the escape of carbonic acid gas,—are facts clearly proving that carbonate of lime is as a constituent of sea-water neither rare of occurrence, nor unimportant in the œconomy of nature, inasmuch as the phænomena alluded to,—the one destructive, the other restorative,—have been observed in most parts of our globe where geological inquiry has been instituted.

Reflecting on the subject, it seemed to me desirable to ascertain whether carbonate of lime as an ingredient of sea-water is chiefly confined to the proximity of coasts, or not so limited enters into the composition of the ocean in its widest expanse.

On a voyage from Barbados in the West Indies to England in November last (1848), I availed myself of the opportunity to make some trials to endeavour to determine this, the results of which I shall now briefly relate.

First, I may mention that water from Carlisle Bay in Barbados, tested for carbonate of lime, gave strong indications of its presence; thus a well-marked precipitate was produced by ammonia, after the addition of muriate of ammonia in excess, that is, more than was sufficient to prevent the separation of the magnesia which enters so largely into the composition of sea-water; and a like effect was produced either by boiling the water so as to expel the carbonic acid, or by evaporation to dryness and resolution of the soluble salts.

On the voyage across the Atlantic, the test by means of ammonia and muriate of ammonia was employed, acting on about a pint of water taken from the surface. The first trial was made on the 15th of November, when in latitude 20° 30′ N., and longitude 63° 20′ W., more than a hundred miles from any land; the result was negative. Further trials were made on the 22nd of the same month in lat. 32° 53′, long. 45° 10′; on the 24th, in lat. 36° 23′, long. 37° 21′; on the 25th, in lat. 37° 21′, long. 33° 34′; on the 26th, in lat. 38° 28′, long. 30° 2′; on the 27th, when off Funchal of the Western Islands, in lat. 38° 32′, long. 28° 40′, about a mile and a half from the shore, the water deep blue, as it always is out of soundings: in all these instances likewise the results were negative; the transparency of the water was nowise impaired by the test applied. The last trial was made on the 3rd of December, when in the Channel off Portland Head, about fifteen miles; now, slight traces of carbonate of lime were obtained, a just perceptible turbidness being produced.

The sea-water from Carlisle Bay, the shore of which and the adjoining coast are calcareous, yielded about 1 per 10,000 of carbonate of lime, after evaporation of the water to dryness, and the resolution of the saline matter. A specimen of water taken up on the voyage off the volcanic island of Fayal, about a mile from land, yielded a residue which consisted chiefly of sulphate of lime, with a very little carbonate of lime,—a mere trace; acted on by an acid it gave off only a very few minute air-bubbles. A specimen taken up off Portland Head, about fifteen miles, yielded on evaporation and resolution of the saline matter only a very minute residue, about ·4 only per 10,000; it consisted in part of carbonate and in part of sulphate of lime.

What may be inferred from these results? Do they not tend to prove that carbonate of lime, except in very minute proportion, does not belong to water of the ocean at any great distance from land? And, further, do they not favour the inference, that when in notable proportion, it is in consequence of proximity to land, and of land, the shores of which are formed chiefly of calcareous rock? In using the word proximity, I would not limit the distance implied to a few miles, but rather to fifty or a hundred, as I am acquainted with shores consisting of volcanic islands in the Caribbean sea destitute of calcareous rock, on which, in certain situations, sandstone is now forming by the deposition from sea-water of carbonate of lime.

Should these inferences be confirmed by more extensive inquiry, they will harmonize well with the facts first referred to, the solvent power, on one hand, of sea-water impregnated with carbonic acid on cliffs of calcareous rock in situations not favourable to the disengagement of carbonic acid gas; and the deposition, on the other hand, of carbonate of lime to perform the part of a cement on sand, converting it into sandstone, in warm shallows, where the waves break under circumstances, such as these are, favourable to the disengagement of this gas; and, I hardly need add, that the same inferences will accord well with what may be supposed to be the requirements of organization, in the instances of all those living things inhabiting the sea, into the hard parts of which carbonate of lime enters as an element.

Apart from the œconomy of nature, the subject under consideration is not without interest in another relation,—I allude to steam navigation. The boilers of sea-going steam-vessels are liable to suffer from an incrustation of solid matter firmly adhering and with difficulty detached, liable to be formed on their inside, owing to a deposition which takes place from the salt water used for the production of steam. On one occasion that I examined a portion of such an incrustation taken from the boiler of the "Conway," a vessel belonging to the West Indian Steam Packet Company, I found it to consist principally of sulphate of lime, and to contain a small proportion only of carbonate of lime. This vessel had been employed previously in transatlantic voyages, and also in intercolonial ones, plying between Bermudas and the Island of St. Thomas, and in the Caribbean sea and the Gulf of Mexico.

The composition of this incrustation, like the preceding results would seem to denote, if any satisfactory inference may be drawn from it, that carbonate of lime is in small proportion in deep water distant from land, and that sulphate of lime is commonly more abundant. The results of a few trials I have made, whilst rather confirmatory of this conclusion, showed marked differences as to the proportion of sulphate of lime in sea-water in different situations. That from Carlisle Bay was found to contain 11·3 per 10,000. A specimen taken up in lat. 29° 19′ and long. 50° 45′, yielded about 2 per 10,000, with a trace of carbonate of lime. A specimen taken up off Fayal yielded about 9 per 10,000, also with a trace of carbonate of lime. One taken up off Portland Head, about fifteen miles

distant, yielded, as already remarked, only ·4 per 10,000, part of which was sulphate, part carbonate of lime.

By certain management, I am informed, as by not allowing the sea-water in the boilers to be concentrated beyond a certain degree, the incrustation, in the instances of the transatlantic steamers, is in a great measure prevented. Perhaps it might be prevented altogether, were sea-water never used but with this precaution, and taken up at a good distance from land, and in situations where it is known that the proportion of sulphate of lime is small. If this suggestion be of any worth, further, more extensive and exact inquiry will be requisite to determine the proportion of sulphate of lime in different parts of the ocean, and more especially towards land. By the aid of the transatlantic steam navigation companies means for such an inquiry may easily be obtained; and it can hardly be doubted that the results will amply repay any cost or trouble incurred.

Lesketh How, Ambleside,
March 29, 1849.

2. "On the Universal Law of Attraction, including that of Gravitation, as a particular case of approximation deducible from the principle that equal and similar particles of matter move similarly, relatively to each other." By John Kinnersley Smythies, Esq. Communicated by T. F. Ellis, Esq., F.R.S.

After stating the general object of his investigations and explaining the notation he employs, the author enters upon some preliminary geometrical inquiries. He gives the equation between the six right lines drawn between four points in a plane; the solidity of a tetrahedron in terms of its edges: the equation between the cosines of the six angles made by four right lines meeting in a point; and the equation between ten right lines drawn between five points, with some formulæ of verification. Giving some general rules for the transformation and consolidation of series, he transforms the last equation into one involving the solidities of tetrahedrons, and shows how the sign of each tetrahedron in that equation is determined by its position relatively to the least solid including them all; and then gives the equation between all the right lines drawn between n points.

Having shown that the result of differentiating the product of n variables, m times successively may be derived from the mth power of the sum of the n variables, developed by the polynomial theorem by substituting for every power of each variable its differential of an order numerically the same as the power; and applied the theorem to find the differential of the mth order of the equation between ten right lines drawn between five points; the author gives the first four successive differentials of the same equation in another form.

Proceeding with his investigation he deduces the necessary equation between the distances and central forces of five moving points, and derives from it the general system of equations which determine the motion of any number of spheres in terms of ϕ (the function of the distance according to which the attractive force varies), their